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ASSESSING THE MERCURY HEALTH RISKS ASSOCIATED WITH COAL-FIRED POWER PLANTS: IMPACTS OF NEW RESEARCH

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Mercury Topics Continue to Be Active Areas of Research

Searches of MEDLINE from 2002 to present found the following numbers of citations, by combinations of keywords:

	Hg	MeHg	fish	coal	coal + fish	PCBs
Hg	1438		195	28	3	36
MeHg		222	71	1	1	7
fish			8988	18		183
coal				510		2
coal + fish					18	0
coal + MeHg						4
PCBs						981

1. No epidemiology of biological monitoring has linked coal Hg with human health effects.
2. Studies of Hg+PCBs are limited to the Faeroe Islands (whale diet) and the U.S. Great Lakes.

Issues in Atmospheric Process (I)
Are there urban sources of Hg? Both air and water pathways must be considered.

1. **Excess atmospheric and precipitation Hg in Chicago.**
   (Landis et al., ES&T 36:4508)
2. **Higher gaseous Hg and wet dep in urban Connecticut.**
   (Nadim et al., Chemosphere 45: 1033)
3. **Hg particles washed from rooftops.**
   (Van Metre & Mahler, Chemosphere 52: 1727)
4. **Excess Hg in dew.**
   (Malcolm & Keeler, ES&T 36:2815)
5. **Hg from dental amalgam in urban wastewater.**
   (Sorme & Lagerkvist, Scit Tot Envir 298:131)
6. **Excess Hg in indoor air.**
   (Carpi &Chen, ES&T 35: 4170)

All of these factors suggest that urban sources of Hg should be considered and monitored properly.

Issues in Atmospheric Processes (II)
Is there local evidence of power plant impacts?

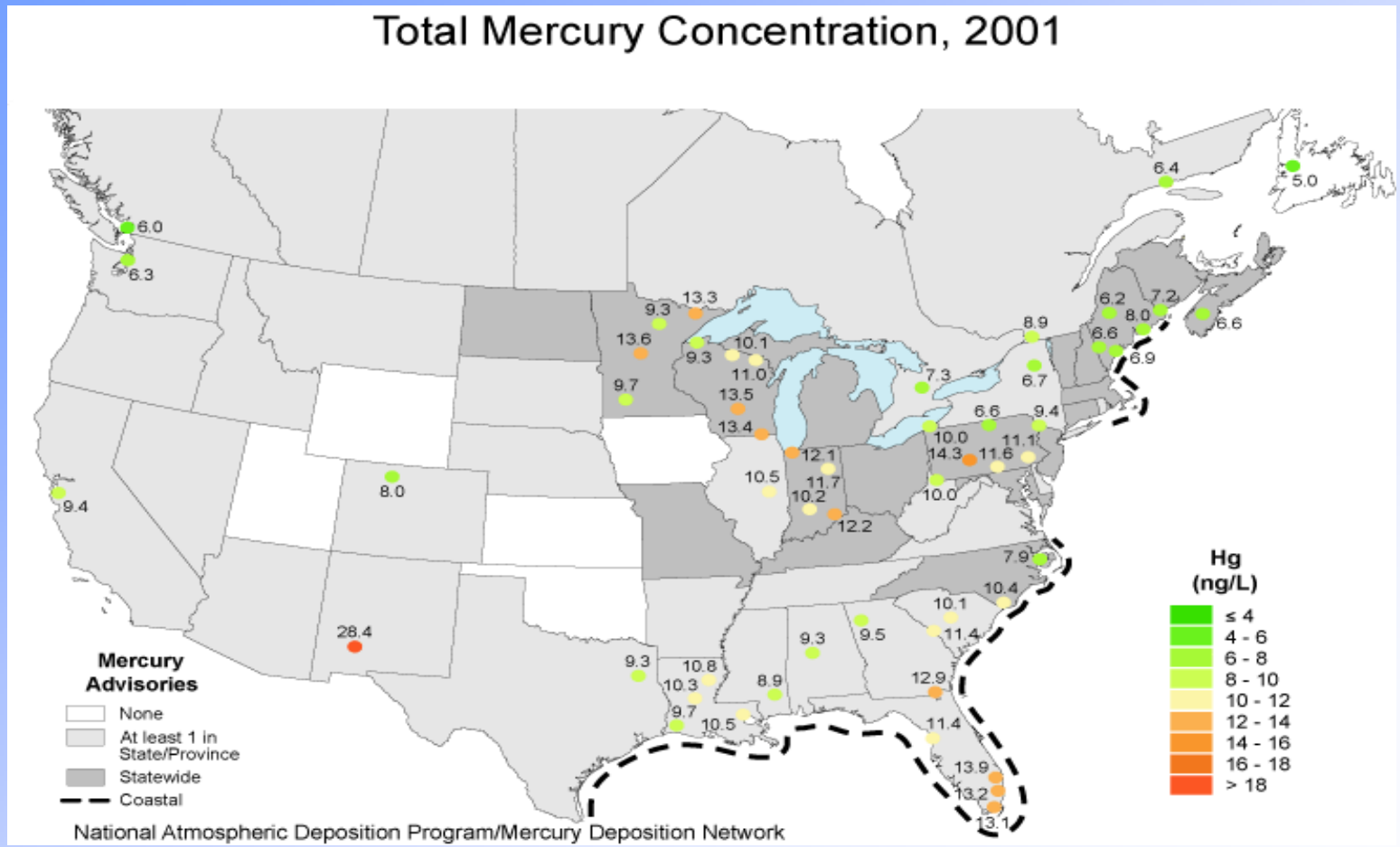
1. **Excess metals in Texas lakes close to power plants.**
   (Menounou & Presley, Arch Environ Contam Tox 45:11)
2. **Excess Hg in Spanish cattle raised near power plants.**
   (Alonzo et al., Environ. Pollution 125:173)
3. **Higher Hg in soils near a Chinese power plant.**
   (Horvat et al., Sci Tot Environ 304: 231)
4. **Atmospheric dispersion models show small excess risks.**
   (Sullivan et al., AQ IV)

Issues in Atmospheric Processes: Is there local evidence of power plant impacts? (cont'd)

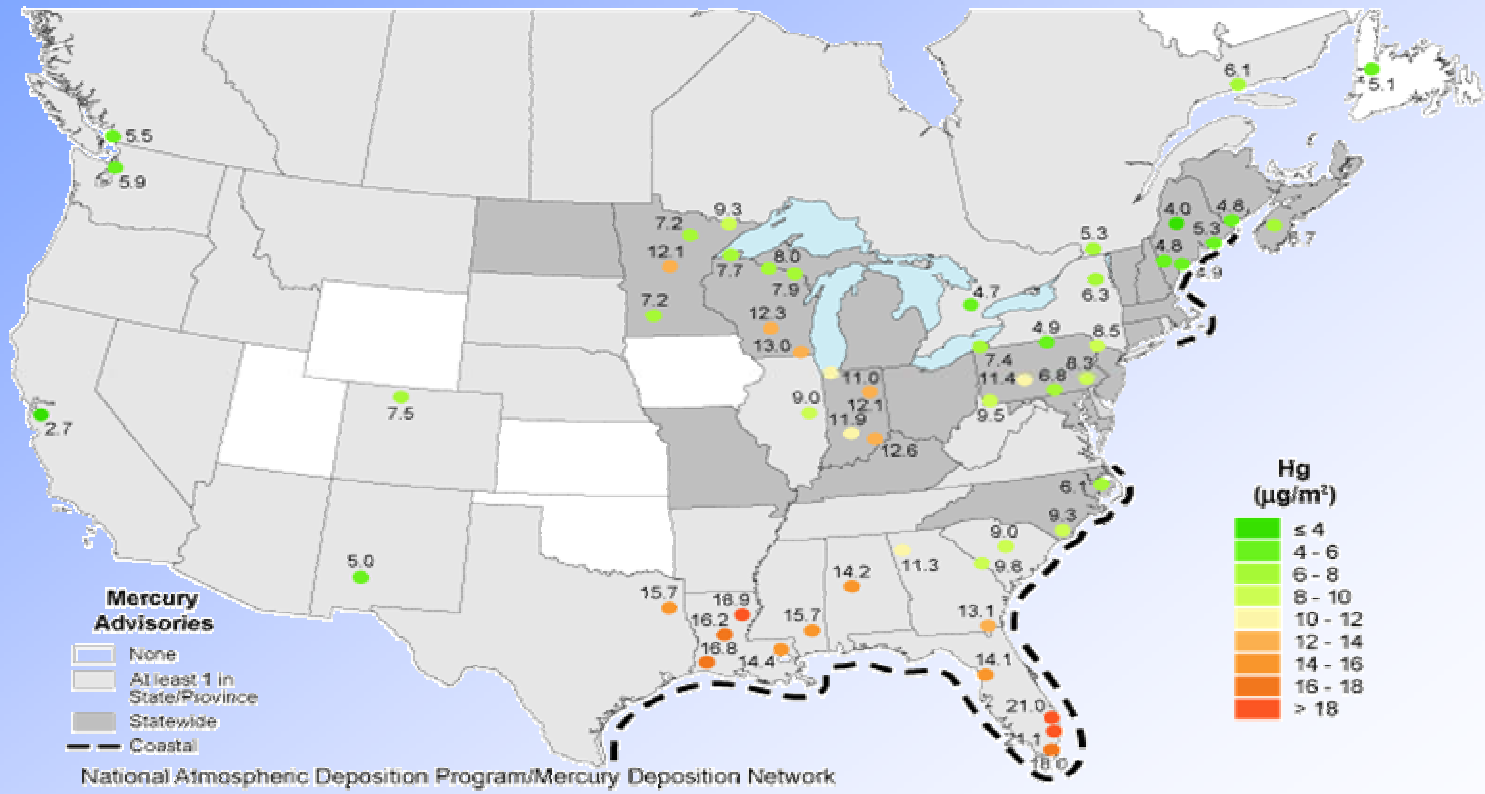
However,

1. **Power plant plumes are low in ozone, which reduces Hg oxidation.** (Weiss-Penzias et al., ES&T 37:3755)
2. **Plume chemistry shows evidence of Hg+ reduction.** (Jansen et al., presented at AQ III)
3. **No significant spacial relationship between fish Hg and local Hg deposition.** (Bucholtz & Lutter, 2002)
4. **The types of vegetation receiving Hg deposition can be important.** (Hintelmann, ES&T 36:5034; Lawson, J Env Mon 5:578)

Conclusion: It depends!


Total Mercury Concentration, 2001
Mercury Advisories
None
At least 1 in State/Province
Statewide
Coastal
Hg (ng/L)
≤ 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
> 18
National Atmospheric Deposition Program/Mercury Deposition Network

Total Mercury Wet Deposition, 2001



Issues in Exposure to MeHg (I)
Linkage between US exposures and epidemiological evidence is problematic.

1. **NHANES data on Hg in blood have been released, but data on hair Hg have not. US blood Hg levels are low.**
   (Schober et al., JAMA 289:1667)
2. **Faeroes evidence is based on umilical cord blood Hg. Linkage with maternal blood/hair Hg is under study.**
   (Stern & Smith, EHP 111:1465)
3. **PCB exposures in the Faeroes were the highest among 9 studies, including 6 US studies in 16 locations.**
   (Longnecker et al., EHP 111:65)
4. **Other dietary components matter, especially fruits.**
   (Clarkson & Strain, J Nutrition 133:1539S; Passos et al., Environ Research 93:123; Furst, Int J Toxicology 21:419)

Consideration of relative exposures and total diets may help resolve differences between epidemiology studies in the Seychelles and in the Faroe Islands.

Other Issues in Exposure to MeHg

1. **Fish consumption by US subsistence populations is consistent with the upper tail of the distribution of the entire US population. Risks to subsistence fishers may thus not need to be considered separately.** (Lipfert et al., AQ III; Moya &Phillipps, JEAEE 11:398; Rothschild & Duffy, Alaska Med 44:89)
2. **Other frequent consumers of gamefish also conform to the high end of the US total population.** (Hightower & Moore, EHP 111:604)
3. **US pregnant women have reduced their fish MdHg intake about 20% and thus should be considered separately.** (Oken et al., Obstetrics & Gynecology 102:346)
4. **There may be sources of dietary MeHg other than fish.** (Bjornberg et al., EHP 111:637)
5. **There may be nuerotoxins (PCBs, Pb) in fish other than MeHg.** (Mendola et al., MRDDRR 8:188; Nakai & Satoh, Tohoku J Exp Med 196:89)

New Epidemiology Findings

1. **Still no adverse effects in the Seychelles cohort (exposed to MeHg but not to PCBs)**
   (Myers et al., Lancet 361:1667, 1686; Lancet 362:664)
2. **Exposure measurement errors did not affect the Seychelles study but could have shifted the blame from PCBs to MeHg in the Faeroes study.**
   (Huang et al., Environ Research 93:115; Budtz-Jorgensen et al., Env Hlth 1:1)
3. **A study of Great Lakes fish-eaters found significant adverse prenatal effects of MeHg only in combination with PCBs**
   (Stewart et al., Neurotox & Teratology 25:11)
4. **Reviews of PCB studies find mixed results:**
   No overall significant effects on 8-mo olds at 12 US sites (1959-65 data)
   (Daniels et al., Am J Epidem 157:485)
   Adverse effects reported at 6 of 7 sites (10 of 11 studies, various ages).
   (Schantz et al., EHP 111:357)S

New Epidemiology Findings (conclusions)

The Seychelles findings are the most robust and the easiest to interpret; they do not rule out adverse prenatal effects of MeHg above ca. 12 ppm in hair.

(T. Clarkson, Sept. 12, 2002)

Fewer than 0.01% of US women aged 18-49 are exposed to MeHg at this level, according to an FDA analysis.

(Carrington & Bolger, Risk Analysis 22:689)

Other Health Effects of Mercury

1. **Timerosal in children's vaccines: No effect on autism.**
   (Madsen et al., Pediatrics 112:604)
2. **Neuropsychological function in adults: reduced fine motor speed and dexterity and effects on memory for hair Hg> ca. 6 ppm, in Brazillian natives.**
   (Yokoo et al., Env Hlth 2:8)
3. **Mercury in dental fillings: any resulting exposures to inorganic Hg are well below toxic levels; patients' complaints are attributed to underlying psychological problems.**
   (Gottwald et al., Psychother Psychosom 71:223)
4. **Cardiovascular effects: The beneficial effects of eating fish may be partially offset if mercury levels are high enough. The literature is contradictory on this point.**
   (Yoshizawa et al., NEJM 347:1755; Guallar et al., NEJM 347:1747; Hu etal., JAMA 287:1815)

Other Health Effects of Mercury (cont'd)

5. **Others: Eating fish at least weekly may reduce the risk of Alzheimer's disease by 60% (mercury content per se was apparently not considered.** (Morris et al., Archives of Neurology 60:940)

Overall assessment:
The US population should keep eating fish!

What Do Recent Reviews Say About Risks of Prenatal Exposure to MeHg?

1. **According to some, "a safe level of MeHg exposure for fetuses has not been determined".** (Evans, JOGNN 31:715) **Others say that up to 4 cans of tuna/wk would be safe (0.24 µg/kg/d).** (Yagev & Koren, Can Fam Phys 48:619)
2. **EPA has set 0.1 µg/kg body weight as the daily MeHg intake likely to be without appreciable lifetime risks.**
   (Rice et al., Risk Analysis 23:107)
3. **The joint FAO/WHO Expert Committee on Food Additives set their limit at 0.23 µg/kg body weight, based on the estimated safe limit (threshold of 1.5 µg/kg/d.**
   (from Web report of the June 2003 meeting)
4. **The US Food and Drug Administration (FDA) has a daily MeHg intake limit of 0.4 µg/kg body weight and reports that the 0.1 level is "well below" exposures reported to be associated with subtle deficits in child development.**
   (Bolger &Schwetz, NEJM 347:1735)
5. **EPA's analysis of benefits from the *Clear Skies* initiative claimed no specific health benefits from reducing Hg emissions from power plants.**
   (report downloaded from Web)

Conclusions: Context is Everything

1. Hg is emitted from power plants along with other pollutants that can affect subsequent atmospheric chemistry.
2. The pathways from Hg emissions to Hg in fish are still poorly understood.
3. Only a few coal-fired power plants will have local impacts on water bodies used for subsistence fishing
4. People who eat large amounts of fish are likely to have diets deficient in other essential nutrients.
5. Risk to pregnant females cannot be reliably predicted from exposure studies based on the general public.

Conclusions: Context is Everything (cont'd)

6. Reducing the MeHg in freshwater fish will not necessarily make them safe to eat.
7. Global reductions in Hg emissions will be required to reduce Hg in the ocean fish that are widely consumed.
8. It is important not to confuse a public health advisory level with threshold of actual harm.
9. Funding of the research required to complete our understanding of airborne Hg should be commensurate with the costs of control.